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SCRUTINY OF MACHINE ASSIGNMENT IN VARIOUS INTRA-CELL LAYOUT IN CELLULAR MANUFACTURING USING AUTOMATION STUDIOS

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ABSTRACT

This paper deals with the Cellular Manufacturing System and it explains the application of the Group Technology philosophy that allows decomposing a manufacturing system into subsystems which makes its management easier than the entire manufacturing system. In this paper we follow the steps to identify the optimum layout design developed by genetic algorithm ,in that we select the optimum sequences and we proposed to develop a model to design single row intra cell layout for the three type's namely linear ,L shape, U and S shape by using automation studio simulation software layout optimization using ARENA . The objective of this work is to find the best layout among these three types which minimize the intra cell movements in both static and dynamic environment in cellular manufacturing systems.

KEYWORDS: Cellular Manufacturing, Intra-Cell Layout, Static environment, Automation, Linear Row Layout, Design of Single Layout

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INTRODUCTION

Cellular Manufacturing(CM) System is an application of the Group Technology philosophy that allows decomposing a manufacturing system into subsystems which makes its management easier than the entire manufacturing system. . Implementation of this lean method often represents the first major shift in production activity, and it is the key enabler of increased production velocity and flexibility, as well as the reduction of capital requirements. Rather than processing multiple parts before sending them on to the next machine or process step (as is the case in batch-and-queue, or large-lot production), cellular manufacturing aims to move products through the manufacturing process one-piece at a time, at a rate determined by customers' needs. It can also provide companies with the flexibility to vary product type or features on the production line in response to specific customer demands. It is a model for workplace design, and has become an integral part of lean manufacturing systems. Cellular Manufacturing is based upon the principles of Group Technology. By implementing Cellular manufacturing significant improvements can be achieved in areas such as lead times, setup time's work- in- process, quality, and machine utilization and employee satisfaction, reduction in material handling cost, better quality, production control, increment in flexibility. The major design for cellular manufacturing involves three The goal of lean manufacturing is the aggressive minimization of waste, and to achieve maximum efficiency of resources. stages: Grouping of parts and production equipment in to cells, Allocation of the machine cells to areas within the shop floor (inter cell or facility layout).Layout of the machines within each cell (intra-cell or machine layout) in which the layout involves to deciding where to put all the facilities, machines, equipment and staff in the manufacturing operation within the

cell and it determines the way in which materials and other inputs like people and information flow through the operation. Relatively small changes in the position of a machine in a factory can affect the flow of materials considerably. In cellular layout, different types of machines may be arranged in a single row as close as possible to the sequence of operation.

Problem Identification and Findings

The facility layout in cellular manufacturing systems the arrangement of cells within the floor space, so as to minimize the inter-cell layout movement. The machine layout in cellular manufacturing systems involves the arrangement of machines within the cells so as to minimize the intra-cell movement. Three basic types of machine layout is identified by Hassan. M. M.D [1] are

Single Row Layout

In this layout, different types of machines may be arranged in a single row as close as possible to the sequence of operations. The layout may be assuming several shapes such as linear, semi-circular or U-shaped.

Multi-Row Layout

The machines are arranged in more than one row in this type of layout. The machines in each row interacts with each other and as well as with the machines in other rows.

Loop Layout

In this layout, the machines are arranged around an oval path and the movement of parts is usually unidirectional.

The static machine cellular layout (SMCL) is designed to work with fixed quantitative demand. But today’s consumer market there is frequent changes in product mix and demand, which cannot be accommodated by SMCL.

Wang. T.Y [2] proposed a model to solve both inter and intra facility layout problem in cellular manufacturing system with a objective of minimizing total material handling cost by Simulated annealing algorithm. He considered the concept of product life cycle, as planning horizon, demand varies during that period. But he did not consider the relay out. Chan. W. M. [3] proposed MAIN algorithm, a heuristic approach to solve the problems in both static and dynamic environment in cellular manufacturing system to minimize the total cost which is the sum of material handling cost and relocation cost. Hence, the objective of this paper is to present a model to solve the linear single row intra-cell layout problems in cellular manufacturing system under static environment to minimize the transportation cost .And find the optimum static layout design in with comparison of single row layout with possible sequence of operations. Also find the minimum transportation cost for resulted sequences. These are fineded using ARENA simulation software Arena, using this software we builds an experiment model by placing modules that represent processes or logic[4]Shahram Saeedi has explained about the concept of heristic approach is highly effective to minimize the intra-cell movements and this type of optimization techniques is used to achieve the optimum results comparing the other technique. [5]P. Vrat examined that the concept of implementing the software technique is the objective to improve the performance, by delivering high quality products in a timely manner, with shorter lead-times and lower costs.[6] YousefNejatbakhsh said that Computational experience on such small problems shows the significant of model and solving algorithm also comparison of results with software have good compactability answers.[7]S.M. Mirgorbani the objective of analysis a problem using software is to minimize the total cost incurred by intra-cell movements.[8] S. Ahkioon had find out and sugguest that the best cell configuration and part routings for one period using any software.[9]M. Murugan,a, had proposed that Comparison and

evaluations are performed using software's better in performance measures .But One important issue related to the implementation of cellular manufacturing systems (CMSs) is to decide whether to convert an existing job shop into a CMS comprehensively in a single run, or in stages incrementally by forming cells one after the other, taking the advantage of the experiences of implementation From the computational analyses, the proposed algorithm is found much more efficient than the fast non-dominated sorting genetic algorithm (NSGA-II) in generating Pareto optimal fronts[11] Reza Tavakkoli, the idea given by this author we have to compare the results with using quality analysis chart. Layout determines the way in which materials and other inputs (like people and information) flow through the operation. Relatively small changes in the position of a machine in a factory can affect the flow of materials considerably. This in turn can affect the costs and effectiveness of the overall manufacturing operation. Getting it wrong can lead to inefficiency, inflexibility, large volumes of inventory and work in progress, high costs and unhappy customers. Changing a layout can be expensive and difficult, so it is best to get it right first time.

PROBLEM FORMULATION

This paper aims in developing the models to determine the total cost, a sum of material handling cost and relocation cost for the planning horizon, when the machines are assigned in a linear single row of a cellular manufacturing system. From the reference paper by Hassan.M.M.D [1] we have taken the material handling values and their results of single row layouts comparing to give optimum layout in static environment.

And we will focus on applying the software to find optimum layout by the assumptions required for solving the problem are:

- The cell formation is completed first, i.e. the machines belongingness to cell are known
- Size of any machine location zone (x, y) can accommodate the largest machine in that particular cell.
- A machine can be assigned to any location.
- The loading and unloading point is at the centre of each machine.
- The distance between any two neighbouring machines in the cell is equal.
- Travelling distance is estimated by measuring the rectilinear distance from centre of the machine to the centre of the destination machine.

The main objective of this model is to minimize the total cost in a planning horizon and it is defined as a sum of Material handling cost and Relocation cost. Also find the optimal single row layout in static environment.

Minimize $\Omega = \sum_{\mathrm{p}=1}^{\mathrm{p}} \xi + \sum_{p=1}^{p-1} \lambda_{\ \mathrm{p} \leftrightarrow \mathrm{p}+1}$

Material Handling Cost

The material handling cost depends on parts to be moved between machines according to the sequence of operation. The material movement is calculated using Manhattan method.

Material handling cost, $\xi = \zeta_p \times \ \omega$

Where,

$$\zeta_p = \sum_{j=1}^{m} \sum_{k=j+1}^{m} D_{j \leftrightarrow k} * Q_{p=i}$$

$$D_{j \leftrightarrow k} = \left| X_j - X_k \right| + \left| Y_j - Y_k \right|$$

Where,

Ω = Total cost, ξ = Material handling cost

ζ = Total travelling distance

ω = Unit cost for travelling score ,P: Planning period, P= 1… P; i: Type of part, i =1,….n; j ,k : a machinepair, j,k =1,…. m; j ≠ k , Q:Quain a planning period; D.

Table 1: Quantitative Values in Static Environment

Parts	Period 1	Period 2	Period 3
1	10	35	90
2	30	50	25
3	45	15	40
4	70	80	55
5	85	60	70

Table 2: Comparisons between Linear Single Row Layouts

S.no	Sequence of Layout	From document (Total. Cost in Rs)	Using Software (Total. Cost in Rs)
1	1 7 6 5 4 2 8 9 3	4480	4209
2	1 4 6 2 7 5 8 3 9	4410	4011
3	1 3 5 8 7 9 2 6 4	4940	4979

Table 3: Comparison between Linear& L Shape Single Row Layouts

S.no	Sequence of Layout	From document (Total. Cost in Rs)	Using Software (Total. Cost in Rs)
1	1 7 6 5 4 2 8 9 3	4480	4295
2	1 4 6 2 7 5 8 3 9	4410	4218
3	1 3 5 8 7 9 2 6 4	4940	4125

Table 4: Comparisions between Linear& U Shape Single Row Layouts

S.no	Sequence of Layout	From Document (Total. Cost in Rs)	Using Software (Total. Cost in Rs)
1	1 7 6 5 4 2 8 9 3	4480	4378
2	1 4 6 2 7 5 8 3 9	4410	4256
3	1 3 5 8 7 9 2 6 4	4940	4641

Table 5: Comparisons between Linear& S Shape Single Row Layouts

S.no	Sequence of Layout	From document (Total. Cost in Rs)	Using Software (Total. Cost in Rs)
1	1 7 6 5 4 2 8 9 3	4480	4682
Table 5: Contd.,			
2	1 4 6 2 7 5 8 3 9	4410	4462
3	1 3 5 8 7 9 2 6 4	4940	5259

NUMERICAL ILLUSTRATION

To illustrate the model, a numerical example is taken from literature. The problem involves 5 parts that are processed in 9machines.Details about the operational sequence quantitative demands and Machine rearrangement cost in a 3 period-planning horizon are furnished in table 1.The material handling cost per unit distance is taken as 10.In the operational sequence of parts with their production of parts in one day and their quantitative values are clearly shown in that table 1 moreover the problem involves in 9 machine we consider the minimum cost for their production the major machines are given within the planning horizon in static environment.

RESULTS AND DISCUSSIONS

We have considered the optimum layout sequence with the order for various parts and no of days are given as inputs. The optimal arrangement of machines and traveling distances for each part in linear single row and multi row layouts are obtained. And finally compare the results with Operational sequence and quantitative demand for various periods are given as inputs. The optimal arrangement of machines and traveling distances for each day in linear single row layout are obtained material handling cost depends on parts to be moved between machines according to the sequence of operation But the transportation cost depends only the movement and flow of materials in a working layout. we have consider the optimum layout sequence with the order for various parts and no of days are given as inputs. The optimal arrangement of machines and traveling distances for each part in linear single row are obtained. And finally compare the results obtained using software from table 2 the travelled distance and their cost for travel in linear row layout is too high and we obtained the optimum cost using the software, similarly table 3 deals with the comparison of linear and L shape layout table [4] gives the results of linear and U shape single row layout. And the table 5 gives the value to compare the linear and S shape layouts.From above comparison using data and software simulation the optimum single row layout by cost is linear single row layout. In table: 4 gives the optimum sequence of layout in linear movements of machines. Similarly, table: 5 for L shape and table: 6, 7 for U and S shapes layout. M. Solimanpur a [11] had explained in his paper due to differences in computing facilities, the computation time is not available for some of these heuristics. The computation time of the proposed ant algorithm and the ANTS method both obtained and averaged over five runs of these methods for each problem. The result which they calculated using algorithm takes more time and calculations also different. But in software they can’t face those kinds of problems. From their approach we have frame a model using automation studio and find the optimum model with minimum transportation cost. In that the movement of machine with the handling a Part may improve the production rate and minimize the cost of production all literatures gives the easy way to understand and find the optimum layout only through optimizing through software techniques. [12]T. Bektas in-depth discussions on the trade-off between the increased flexibility in layouts, also increase the transportation cost. [13]Reza Tavakkoli, the idea given by this author we have to compare the results with using quality analysis chart. Layout determines the way in which materials and other inputs (like people and information) flow through the operation. In figure 1 gives the optimum arrangement of linear machine array with layout sequence shown in above tables (1-4-6-2-7-5-8-3-9),similarly in all figures we shown the arrangements of machine in various layout formation ,in that figure 2 shows the L-shape machine measures ,figure 3 shows the U-shape and figure 4 shows the S-shape machine arrangement with sequential operations. Concluding layout optimization executed with values that separately executed using ARENA software to find the numerical values of comparison.

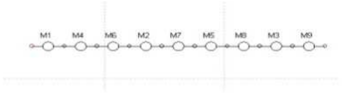

Figure 1: Linear Layout

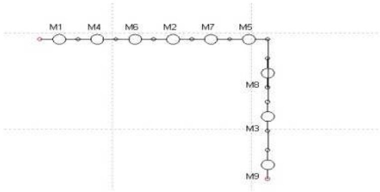

Figure 2: L-Shaped Layout

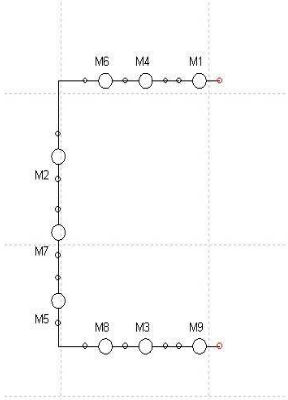

Figure 3: U Shaped Layout

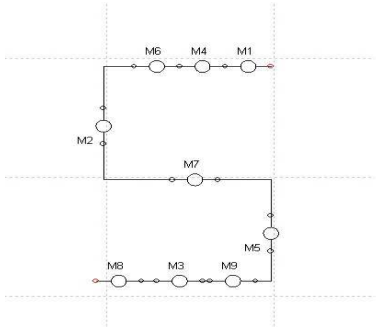

Figure 4: S Shaped Layout

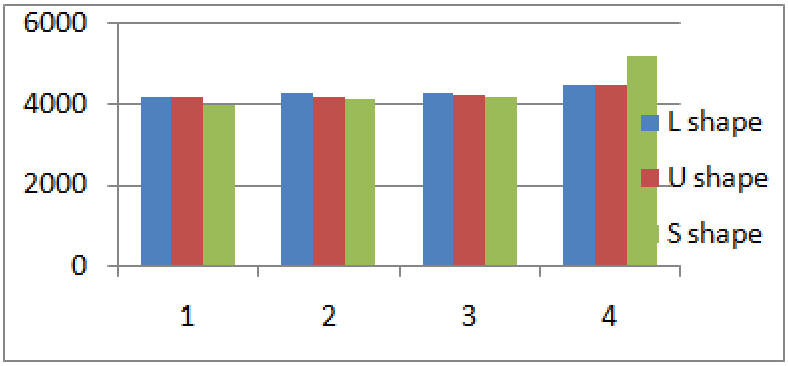

Figure 5: Comparison of Linear, L Shape, U Shape and S Shape Layouts

The above column chart gives the comparison between three layouts of three planning period horizon. From graph the blue bar indicates the L shape layout, the red color indicates the S shape layout similarly the green color indicates the U shape layout. In this graph we easily find the optimum layout with minimum transportation cost.

CONCLUSIONS

Layout determines the way in which materials and other inputs (like people and information) flow through the operation. Relatively small changes in the position of a machine in a factory can affect the flow of materials considerably. This in turn can affect the costs and effectiveness of the overall manufacturing operation. Getting it wrong can lead to inefficiency, inflexibility, large volumes of inventory and work in progress, high costs and unhappy customers. Changing a layout can be expensive and difficult, so it is best to get it right first time.The machine layout in cellular manufacturing systems involves the arrangement of machines within the cells so as to minimize the intra-cell movement. Three basic types of machine layout is identified and we calculate the transportation cost for single row layout in that especially linear, S shape, U shape, and L shape using automation studio simulation software. In that we made the comparison and find that the linear layout has minimum transportation cost than L shape, following that ascending with U and S shape layout using ARENA software. From reference and software values, the optimum layout by cost is linear single row layout in cellular working environment because linear arrangement of machines without any backtracking movements.

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